Messrs. Schæberle and Burckhalter Secretaries, and Mr. Molira Treasurer, until March 30, when a general meeting was to be held for the election of officers and Council, and other necessary business. The seat of the Society is to be in San Francisco, but only half the meetings are to be held there, the other half being proposed to be held at the Lick Observatory during the fine weather of the summer months. A circular setting forth the objects and regulations of the new Society has been widely circulated amongst those most likely to be desirous of joining it.

THE LATE W. E. TEMPEL.—We greatly regret to have to record the death, on March 16, of the Arcetri observer, William Ernest Tempel, so well known as one of the most keen-sighted and careful observers of comets and nebulæ. Herr Tempel, though his astronomical reputation was entirely associated with Marseilles or Italy, was of German extraction, having been born on December 4, 1821, at Nieder-Cunersdorf. His parents were poor, and when he grew up he followed the profession of lithographic artist. He settled down at Venice in 1859, after several wanderings, and here first began his astronomical observations with a 4-inch Steinheil, which he had purchased for himself. Here he discovered his first comet, and the famous Merope nebula. The following year he went to Marseilles, where he acted for some time as assistant at the Observatory, then under the direction of M. Valz. Here he discovered six minor planets, and ten comets, two of which proved to be of short period, and a third was rendered not less important from its being the comet connected with the Leonid meteors. The outbreak of the Franco-German war obliged him to leave France, and he returned to Italy. Giving up his lithography, and devoting himself wholly to astronomy, he acted for four years as Assistant at the Brera Observatory, Milan, and in 1875 he became Astronomer, and practically Director, of the new Observatory at Arcetri, Florence. Five more comets were discovered by him either at Brera or Arcetri, and at this latter place he took up the study of nebulæ, of which he made a great number of exceedingly fine drawings. In latter years his health obliged him to give up the work of observing, but he had already won for himself a distinct and honourable position in the history of the science. He was elected Foreign Associate of the Royal Astronomical Society in 1881, and received the Astronomical Prize of the Lyncean Academy in 1879, besides several from the Imperial Academy of Sciences of Vienna.

THE COMPANION OF SIRIUS.—Mr. Burnham, observing Sirius with the 36-inch telescope of the Lick Observatory during the past winter, finds the place of the companion as under:—

Date of Observation.	Distance.	Position Angle.
1888·97	5″·27	13°·9.

He was not able to see any other near companion.

COMET 1888 *e* (BARNARD, 1888 SEPTEMBER 2).—Herr A. Berberich gives in the *Astr. Nachr.*, No. 2883, the results of a more detailed computation of the orbit of this comet. He has formed nine normal places from observations extending from 1888 September 5 to 1889 February 17, and made at different Observatories, and deduces the following elements:—

$$T = 1889 \text{ January } 31{\cdot}256389.$$

$$\left.\begin{aligned} \omega &= 340^\circ\ 29'\ 22''{\cdot}71 \\ \Omega &= 357\ \ 25\ \ 35{\cdot}00 \\ \iota &= 166\ \ 22\ \ 12{\cdot}20 \end{aligned}\right\}\text{ Mean Eq. } 1889{\cdot}0.$$

$$\log q = 0{\cdot}2587773.$$

The ephemeris shows that the theoretical brightness of the comet will undergo very little change for several months to come, and it will be almost of the same brightness as it was on the night of discovery by the time the anniversary of that date is reached.

Ephemeris for Berlin Midnight.

1889.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
April 6	23 33 55	0 6·7 S.	0·2997	0·4582	1·7
10	23 33 4	0 10·3 N.	0·3043	0·4548	1·7
14	23 32 4	0 27·0 N.	0·3090	0·4508	1·7
18	23 30 53	0 43·2 N.	0·3139	0·4459	1·7
22	23 29 28	0 58·8 N.	0·3189	0·4402	1·7
26	23 27 48	1 13·8 N.	0·3240	0·4337	1·8
30	23 25 51	1 28·1 N.	0·3292	0·4264	1·8

The brightness at discovery is taken as unity.

COMET 1888 *f* (BARNARD, 1888 OCTOBER 30).—The following ephemeris for Berlin midnight for this comet is by Dr. R. Spitaler, *Astr. Nachr.*, No. 2875:—

1889.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
April 6	9 21 22	37 14·3 N.	0·4830	0·4015	0·15
10	9 22 11	37 25·5 N.	0·4886	0·4171	0·14
14	9 23 22	37 33·4 N.	0·4941	0·4323	0·12
18	9 24 52	37 38·5 N.	0·4995	0·4472	0·11
22	9 26 42	37 41·0 N.	0·5049	0·4616	0·10

The brightness at discovery is taken as unity.

SATURN'S RING.—Mr. Keeler, writing to *Gould's Astronomical Journal* under date March 4, states that the very fine division on the outer ring of Saturn, detected with the 36-inch refractor early in 1888, has been recently seen again under specially favourable circumstances. The new division was about one-sixth of the breadth of ring A from its outer edge, and appeared as a distinct dark line of exceeding fineness. A dark shading extended inwards from the new division almost to the inner edge of the ring. The brightest part of the ring was the narrow strip lying outside the new division, and between it and the outer edge. The Lick observers consider this marking a permanent feature of the planet, but one which can only be observed with exceptional instrumental and atmospheric advantages. The shadow of the planet on the ring was carefully watched, but no deformation was detected.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 *APRIL* 7–13.

(**FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.**)

At Greenwich on April 7

Sun rises, 5h. 23m.; souths, 12h. 2m. 4·7s.; sets, 18h. 41m.: right asc. on meridian, 1h. 5·9m.; decl. 7° 1′ N. Sidereal Time at Sunset, 7h. 46m.

Moon (at First Quarter on April 8, 14h.) rises, 9h. 17m.; souths, 17h. 34m.; sets, 1h. 53m.*: right asc. on meridian, 6h. 38·5m.; decl. 22° 30′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. and declination on meridian. h. m.	° ′
Mercury	5 8	11 2	16 56	0 5·5	1 57 S.
Venus	5 35	13 54	22 13	2 58·6	23 43 N.
Mars	5 58	13 14	20 30	2 18·0	13 49 N.
Jupiter	1 35	5 31	9 27	18 33·8	22 56 S.
Saturn	12 20	20 0	3 40*	9 5·1	17 55 N.
Uranus	18 46*	0 13	5 40	13 15·1	7 15 S.
Neptune	7 5	14 50	22 35	3 54·5	18 40 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

April.	h.	
9	13	Venus stationary.
10	13	Saturn in conjunction with and 1° 9′ south of the Moon.

Saturn, April 7.—Outer major axis of outer ring = 43″·1: outer minor axis of outer ring = 12″·3: southern surface visible.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·5	81 17 N.	Apr. 11,	3 34	*m*
R Lyncis	6 52·2	55 29 N.	,, 9,		*M*
U Boötis	14 49·2	18 9 N.	,, 10,		*M*
δ Libræ	14 55·1	8 5 S.	,, 9,	1 34	*m*
U Coronæ	15 13·7	32 3 N.	,, 11,	2 13	*m*
W Scorpii	16 5·3	19 51 S.	,, 10,		*M*
R Ursæ Minoris	16 31·5	72 30 N.	,, 11,		*m*
U Ophiuchi	17 10·9	1 20 N.	,, 10,	2 32	*m*
			and at intervals of	20 8	
R Scuti	18 41·6	5 50 S.	Apr. 8,		*m*
S Delphini	20 38·0	16 41 N.	,, 13,		*m*
T Vulpeculæ	20 46·8	27 50 N.	,, 10,	22 0	*m*
			,, 12,	0 0	*M*
W Cygni	21 31·9	44 53 N.	,, 8,		*m*
δ Cephei	22 25·1	57 51 N.	,, 12,	1 0	*m*

M signifies maximum; *m* minimum.

© 1889 Nature Publishing Group

Meteor-Showers.

	R.A.	Decl.	
Near β Ursæ Majoris	... 164°	... 58° N.	... April 9–12.
,, ζ ,, ,,	... 206	... 57 N.	... Slow; bright.
	249	... 51 N.	... April 9–12.

THE FORCES OF ELECTRIC OSCILLATIONS TREATED ACCORDING TO MAXWELL'S THEORY. BY DR. H. HERTZ.[1]

III.

The Interference Experiments.

IN order to ascertain the velocity of propagation of electric force in the equatorial plane, we brought it into interference with another wave advancing with corresponding constant velocity in a wire. The result was, that the successive interferences did not occur at equal distances, but followed more rapidly in the neighbourhood of the oscillator than at greater distances.

This behaviour was explained by the supposition that the total force could be decomposed into two parts, of which the one, the electrodynamic, travelled with the velocity of light, while the other, the electrostatic, travelled with a greater, perhaps an infinite, velocity.

According to our theory now, however, the force in question in the equatorial plane is—

$$Z = Elm^3 \left\{ -\frac{\sin(mr-nt)}{mr} - \frac{\cos(mr-nt)}{m^2r^2} + \frac{\sin(mr-nt)}{m^3r^3} \right\},$$

and this expression in no way splits up into two simple waves travelling with different velocities. If, then, the present theory is correct, the earlier explanation can only be an approximation to the truth.

We will investigate whether the present theory leads to a general explanation of the phenomenon.

First, we can write $Z = B \sin(nt - \delta_1)$, where the amplitude

$$B = \frac{El}{r^3}\sqrt{(1 - m^2r^2 + m^4r^4)},$$

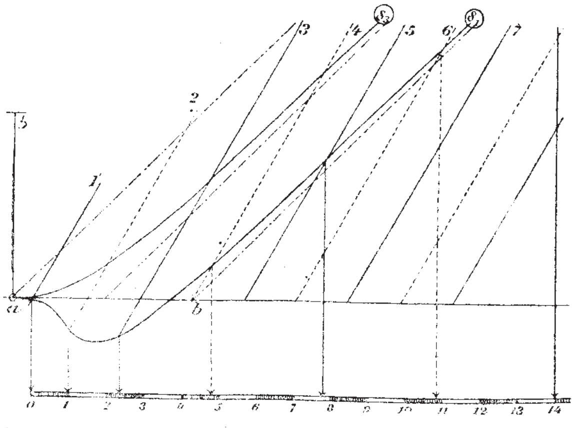
and the phase δ_1 is determined by the equation—

$$\tan \delta_1 = \frac{\frac{\sin mr}{mr} + \frac{\cos mr}{m^2r^2} - \frac{\sin mr}{m^3r^3}}{\frac{\cos mr}{mr} - \frac{\sin mr}{m^2r^2} - \frac{\cos mr}{m^3r^3}};$$

which, after transformation, gives—

$$\delta_1 = mr - \tan^{-1}\frac{mr}{1 - m^2r^2}.$$

In Fig. 5, the quantity δ_1 is represented as a function of mr by the curve labelled δ_1. The length ab corresponds in the figure to the value of π, both for ordinates and abscissæ. If one considers, not mr, but r, as the variable abscissa, the length ab corresponds to the half wave-length.



In order to immediately attach the experiments which we wish to discuss, the abscissa axis is further divided into metres beneath the diagram. From the result of direct measurement (*Wied. Ann.*, xxxiv. p. 609, 1888), λ was equal to 4·8 metres, and thus the scale-length of a metre is determined. The zero of the scale is, however, not at the oscillator, but at a distance of 0·45 metre from it; for in this way the scale corresponds to the actual division of the base-line on which the position of the interferences was determined. One sees from the figure that the phase does not in general spread from the source, but its course is such that the waves arise at a distance of about ½λ from it, and give off thence a part to the conductor and a part out into space. At great distances, the phase is smaller by the value π than it would be if the waves had spread out with constant velocity from the source: the waves therefore behave, at great distances, as if they had traversed the first half wave-length with infinite speed.

The action, w, of the wire-waves at a definite position of the secondary conductor can now in any case be represented by the form $w = C \sin(nt - \delta_2)$; wherein the abbreviation—

$$\delta_2 = m_1r + \delta = \frac{\pi r}{\lambda_1} + \delta$$

is used. λ_1 denotes the half wave-length of the waves in the wire, which in our experiment was 2·8 metres; δ, the phase of its action at the point $r = 0$, which we can arbitrarily change by adjustment of the length of the wire.

By this means we could change the amplitude, C, and give it such a magnitude that the action of the wave in the wire was approximately equal to that of the direct action. The phase of the interference depends, then, only on the difference of the phases δ_1 and δ_2. With the particular adjustment of the secondary circle to which our expression for w refers, both actions correspond (the interference has the sign +) if $\delta_1 - \delta_2$ is equal to zero, or a whole multiple of 2π; the actions disagree (the interference has the sign −) if $\delta_1 - \delta_2$ is equal to π, or any whole multiple of it. No interference occurs (the interference has the sign 0) if $\delta_1 - \delta_2$ is a whole multiple of $\frac{1}{2}\pi$.

We will now so determine δ that at the zero of the metre-divisions the phase of the interference has a definite value, δ_0, so that $\delta_1 = \delta_2 + \delta_0$.

The straight line 1 of our figure shall then represent the value of $\delta_2 + \delta_0$ as a function of the distance. The line is specially drawn with such a slant that for an increase of abscissa by $\lambda_1 = 2{\cdot}8$ metres the ordinate increases by the value π, and is so arranged that it cuts the curve δ_1 in a point whose abscissa is the zero of the metre-divisions.

The lines 2, 3, 4, &c., represent further the course of the values $\delta_2 + \delta_0 - \frac{1}{2}\pi$, $\delta_2 + \delta_0 - \pi$, $\delta_2 + \delta_0 - \frac{3}{2}\pi$, &c. These lines are parallel to the line 1, and so drawn that they cut one and the same ordinate at distances of $\frac{1}{2}\pi$, and one and the same abscissa at distances of 1·4 metre.

Project now the section of these straight lines with the curve δ_1 on the axis of abscissæ below, and one gets immediately those distances for which $\delta_1 = \delta_2 + \delta_0 + \frac{1}{2}\pi$, $\delta_2 + \delta_0 + \pi$, $\delta_2 + \delta_0 + \frac{3}{2}\pi$, &c., for which, therefore, the phase of the interference increases from the origin by $\frac{1}{2}\pi$, π, $\frac{3}{2}\pi$.

One obtains immediately from the figures the following:—

If the interference at the zero of the base-line possesses the sign +(−), it vanishes for the first time at a distance of about 1 metre; it attains the sign −(+) at about 2·3 metres, vanishes again at 4·8 metres, and reverts back to the sign +(−) at about 7·6 metres; it is again 0 at 14 metres, and from thence onward the signs recur at fairly regular intervals. If at the zero of the base-line the interference was zero, it will be zero again at about 2·3, 7·6, and 14 metres, while it has a prominently positive or negative character at about 1 metre, 4·8 metres, 11 metres distance from the zero. For mean phases mean values serve.

If one compares with this result of theory the result of experiment, especially those interferences which occurred with arrangements of 100, 250, 400, 550 centimetres of wire (*Wied. Ann.*, xxxiv. p. 563), one will find a correspondence as complete as can be at all expected.

I do not succeed quite so well in calculating back to the interferences of the second kind (*l.c.*, p. 565). To get these we used an arrangement of secondary circle by which the integral force of induction through the closed circuit came prominently into account. If we regard the dimensions of the latter as vanishingly small, the integral is proportional to the rate of change of the magnetic field normal to the plane of the circle, and hence to the expression—

$$\frac{dP}{dt} = AElm^2n^2 \left\{ -\frac{\cos(mr-nt)}{mr} + \frac{\sin(mr-nt)}{m^2r^2} \right\}.$$

---

[1] Translated and communicated by Dr. Oliver Lodge. Continued from p. 452.

© 1889 Nature Publishing Group